Japan Patent Office (JP) L.S.# 334

Public Report of Opening of Patent

Opening No. of patent: H 10-326571
Date of Opening: Dec. 8, 1998

Int.Cl.	Distinguishing mark	F1		
H 01 J 11/02		H 01 J 11/02		B
9/02		9/02		F
17/16		17/16		
C 03 C 27/06	101	C 03 C 27/06	101	Z

Request for examination: pending
Number of invention: 4 OL

Application No. of Invention: No. H 9-137132
Date of application: May 27, 1997
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DETAILED REPORT

(Name of the invention)
cell walls for plasma display panel and manufacturing method of the same

Outline
(Object)

This invention offers cell walls for a plasma display panel and manufacturing method of the same which reduces defects in the shape of cell walls which form the electric discharge display cell of the PDP. The base of the cell wall which is attached to the back plate is a curved surface which has a uniform radius of curvature. The thickness of the luminous layer on the bottom of the electric discharge display cell is uniform and has no cracks. These cell walls for the PDP form electric discharge display cells which are highly detailed and accurate. These cell walls for the PDP can easily be used for a big screen. The manufacturing method in this invention can be used to produce these cells inexpensively and effectively.

(Construction)

A layer of material for forming cell wall is coated on the back plate and then molded to form the cell walls. These molded cell walls are treated with a release process with the back board. After sintering, they are united and cell walls for a plasma display panel where the shape of the base of the cell walls is a curved surface which has a radius of curvature in the range of 10 to 100 μm is acquired.

Sphere of patent request

(claim 1)

Claim 1 is regarding cell walls for plasma display panel where the shape of the base of the cell walls attached to the back plate is a curved surface which has radius of curvature in the range of 10 to 100 μm. In this plasma display panel, multiple electric discharge display cells are constructed from an insulating substrate, a back plate and front plate, and cell walls which separate the space between the insulating substrates. Multiple electrode groups are set up inside the electric discharge display cell. At the same time, an electric discharge gas contained by an air tight seal. Voltage is selectively applied between the electrodes, and a plasma is produced. A luminous plasma is formed inside the electric discharge display cell, and it is used as the light-emitting element of a display screen device.

(claim 2)

Claim 2 is regarding a manufacturing method for cell walls for a plasma display panel which has the following characteristics. First, material for forming the cell walls is coated on a back plate. Next, this coated layer is molded into cell walls. These molded cell walls are treated with a release process with back board. After sintering, they are united to form cell

walls for a plasma display panel with curved bases which have a radius of curvature in the range of 10 to 100 μm.

(claim 3)

Claim 3 is regarding a manufacturing method for cell walls for a plasma display panel which has the following characteristics. After the cell walls are molded by a plasticizing transformation and pressing the mold for cell wall onto the plastic material, the molded cell walls are tightly bonded by pressing a back plate on the molded cell walls. After releasing them, they are sintered and bonded to the back plate. Cell walls for a plasma display panel where the wall base has a curved surface with a radius of curvature in the range of 10 to 100 μm are acquired.

(claim 4)

Claim 4 is regarding the manufacturing method for cell walls for a plasma display panel in claim 2 or 3 which has the following characteristics. The cell walls are formed by pressing a series of rollers into the cell wall material.

Detailed explanation of the invention

[0001]
(Field of industrial use)

This invention is concerning cell walls for a PDP which are used as the electric discharge display cells of a plasma display panel (a PDP in the following) that is used for a thin, light weight color display screen. This invention be used to make a big, inexpensive screen with high accuracy. This invention also includes a manufacturing method for the same.

[0002]
(Prior art)

CRT's have formerly been used as display screens. However, CRT's are big and heavy and high voltage is necessary. Recently, with the growing popularity of multi media, flat screen display devices such as light emitting diodes (LED) or liquid crystal display elements (LCD) have been developed. Their range of applications has been enlarged.

[0003] Among these, PDP's have been gaining attention as color display devices for big screens. Plasma illumination has high quality, light weight, is thin, and is not particular about its location.

[0004] A PDP is constructed as follows: groups of opposing electrodes are set up in tiny electric discharge display cells between two flat insulating substrates. Cell walls separate these calls. A gas such as a rare gas is sealed in the se cells by an airtight seal. Voltage is selectively applied to the opposing electrodes, and plasma is produced by an electric discharge. Next, a body inside the electric discharge display cell is illuminated by the plasma, and it is used as a light-emitting element of a display screen.

[0005] The following general manufacturing methods for cell walls which constitute the electric discharge display cells of the PDP are well known. In these methods, printing and drying of a paste composition for molding cell walls is repeated on the back plate in the desired pattern by screen printing. The cell wall is formed by forming layers up to the desired height.

[0006] However, in this method the film thickness which can be formed in one printing is approximately 10 μm, so it is necessary to build up the cell walls by repeating printing and drying because the cell walls of an electric discharge display cell require a height of approximately 100 to 200 μm.

[0007] Not only are there too many process steps, but excess material piles up in the bottom of the cells.. In addition, the base of the cell wall which is bonded to the back plate is distorted due to the mesh of the printing plate making. The cell walls are deformed by positioning between repeated printings. In addition to stretch during printing plate making, these factors make it difficult to acquire good dimensional accuracy. This makes a lower limit on the pitch of the cells which can be formed. As a result, it is impossible to satisfy demands of high accuracy. Also, since it is necessary to print with accuracy at every lamination, you can't stop in the middle.

[0008] Therefore, the following methods have been suggested to solve these problems. (Japan patent No. H 8-115669) First, cell wall materials are formed in layers on a back plate to the

necessary thickness. Next, unnecessary parts are polished and removed by sandblasting using a mask, and cell walls in the desired shape are formed.

[0009]
(Problems that this invention tries to solve)

With this sandblasting method, it is possible to form cell walls with the desired standing sectional shape. The base of the cell wall will not be distorted and the bottom part will not be enlarged as in the screen printing lamination method. However, in this processing method, it is necessary to polish and remove a lot of cell wall material other than the part which forms the walls. This makes the cost high.

[0010] In addition, when long, thin and extremely narrow cell walls are molded in order to form electric discharge display cells with even higher accuracy, the high cell walls are weak in the direction perpendicular to the cell walls. Cracks are produced when the cell walls are formed, or during sintering. The cell walls can also be damaged during subsequent handling.

[0011] When the cell walls have a standing sectional shape after sintering as shown in figure 4, the corner 17 formed between the back plate 15 and base of the cell walls 16 is irregularly rounded. When the luminous layer 19 is formed in the bottom of the electric discharge display cell 18, there have been problems completely filling the cell, controlling the thickness of the luminous layer, or cracking 20 during sintering. Also, light-emitting efficiency is reduced and luminosity is uneven.

[0012]
(Object of this invention)

This invention was made in order to solve the above problems. Its object is to offer cell walls for a plasma display panel and a manufacturing method for the same. This reduces defects such as voids in the cell walls which constitute the electric discharge display cells of a PDP, and it improves productivity. The cross section of the base of the cell wall is highly accurate. The cells can have a fine pitch when attached to the back plate. The walls join the base plate in a curved surface with a uniform radius of curvature. The luminous layer formed on the bottom of the electric discharge display cells is uniform and crack free. These cell walls for PDP make highly accurate, detailed electric discharge display cells. These cell walls for PDP can easily be used for a big screen such as 30 inches or more. The manufacturing method in this invention can be used to produce these cell walls inexpensively and effectively.

[0013]
(Steps for solution)

The inventors of this invention made through research on this subject with the following results. The cell walls which form the electric discharge display cells are formed by plastic deformation of the wall material. The cross section is a curved surface with a fixed radius of curvature at the base. Because of this, it is possible to prevent defects such as missing parts during handling or cracking of the cell walls. At the same time, it is possible to form a luminous layer with uniform thickness without defects such as cracks in bottom of electric discharge display cell. High accuracy and high detail can be realized.

[0014] The cell walls in this invention have the following characteristics. The sectional shape of the base of the cell walls makes a curved surface which has a radius of curvature in the range of 10 to 100 μm where it joins the back plate. This shape is formed by plastic deformation of the cell wall material.
[0015] The manufacturing method for cell walls for PDP in this invention has the following characteristic. First, a predetermined thickness of cell wall material is applied in a layer on a back plate. Next, this coated layer plastically deformed into the cell wall shape. The back plate where the cell walls molding has been bonded are debindered and sintered. Cell walls for a plasma display panel where the sectional shape of the wall base where it is attached to the back plate has a curved surface with a radius of curvature in the range of 10 to 100 μm, are acquired.
[0016] In addition, there is another manufacturing method for cell walls for PDP which has the following characteristics. After the cell walls are formed by plastic deformation by directly pressing the wall mold onto the wall material, the molding is tightly bonded to the back plate by pressure. After de-bindering, it is sintered attached to the back plate. Cell walls for a plasma display panel where the base of the cell walls makes a curved surface with a radius of curvature in the range of 10 to 100 μm are acquired.
[0017] Te following method is best for forming cell walls by plastic deformation of the wall material. Multiple groove in the shape of the cell walls are formed. The cell walls are formed by pressing and rotating a roll-shaped mold which has projections in the desired circular shape with a predetermined curvature.

[0018]
(Function)

In the cell walls for PDP and manufacturing method in this invention, the wall section at the base where the wall attaches to the back plate has a radius of curvature in a fixed range. In the manufacturing method, a layer of wall material formed on a back plate is plastically deformed to form the cell walls. After this cell wall molding is de-bindered, it is sintered, and attached to the back plate. Therefore, the wall base will be a curved surface with a uniform radius of curvature. It is also possible to reduce stress concentration at the cell wall base. At the same time, it is possible to increase the sectional area of the cell walls compared to cell walls which consist of only long thin sectional shapes. It is possible to improve the strength of the cell walls in the direction perpendicular to the length.. The manufacturing process is improved by reducing defects such as deformation or voids in the cell walls. The base of the cell walls will have a uniform curved surface and they can be easily reproduced by a simple process. It is also possible to make a uniform layer of luminous material. Overall, reduce manufacturing costs can be greatly reduced.

[0019]
(State of practice of this invention)

In the following, cell walls for PDP of this invention and the manufacturing method are going to be explained in detail based on figures.
[0020] Figure 1 shows one example of practice of a PDP which uses the cell walls in this invention. Figure 2 is a section of the main part of the cell walls for PDP in this invention.

[0021] In figure 1 and figure 2, 1 is the cell walls for PDP used in the PDP 9 that consists of an insulating substrate 4 used to make a back plate 2 and a front plate 3, and electric discharge cell 5 which has multiple electrodes 6, 7 and luminous material 8.
[0022] In the cell wall 1 for PDP, the cell wall section at the base 10 where they attach to the back plate 2 has a uniform curved surface 11 within a fixed range curvature.
[0023] In this invention, the radius of concerning of the curved surface 11 made by the base part 10 of the cell walls attached to the back plate 2 must be greater than 10 μm and less than 100 μm . When even one part of the curved surface 11 is less than 10 μm looking from the center direction of the electric discharge display cell 5, the effect of this invention which reduces deformation or missing parts is reduced. On the other hand, if it exceeds 100 μm, although cell wall durability is improved, the luminous area is reduced luminosity is decreased.
[0024] As long as the radius of the curved surface 11 made by the cell wall base 10, regardless of size electric discharge display cell 5, is in the range of 10 to 100 μm, it can have a fixed radius of curvature, it can be an oval where the radius of curvature is continually changing, or other curved surface with various shapes. Among these, for case of manufacturing the mold, 15 to 70 μm is the best.
[0025] Next, the manufacturing method for cell walls for PDP in this invention is going to be explained. In the example shown in figure 3, a layer 12 of cell wall material is formed on a back plate 2 and plastically deformed to form cell walls 1 for PDP. The cell wall section will be a curved surface 11 with a fixed radius of curvature.
[0026] The following method is especially efficient, and it makes mass-production with high accuracy possible. First, a roll-shaped mold 14 with multiple grooves 13 equivalent to the shape of the cell walls and having the desired radius of curvature for the wall base is pressed onto a layer 12 of cell wall material while rotating in the direction of the arrow. Next, the shape of the cell walls is transcribed by plastic deformation of the coated layer 12. A cell wall molding which has a curved surface 11 at the wall base attached to a back plate 2 is acquired.
[0027] The plastic deformation process for the layer of cell wall material is not specifically limited. For instance, in addition to forming the cell wall molding by pressing various kinds of flat or roll shaped molds corresponding to the sectional shape of cell walls into the layer on the back plate, it is possible to press the mold for cell walls above onto the cell wall material without a backing plate. In another method, it is possible after pressing the mold into the cell wall material or pressing the cell wall material onto the mold to transcribe the back plate and press the cell wall material onto it.
[0028] As long as the cell wall material becomes hard after sintering and is airtight, any material can be used. For instance, it is possible to use a mixture of low-melting point glass powder and ceramic oxide powder as inorganic components. A mixture of inorganic components and organic substances such as binders, solvents, or various kinds of additives can be used depending on the requirements of the molding method.
[0029] Organic binders which are suitable materials for molding cell walls include, for example, acryl or butyral based thermo plastic binders or reaction curing resins such as UV curing, light-curing, or thermal curing resin.
[0030] The method for plastic deformation of the coated layer of cell wall material above which is formed on back board can include, other than adding organic substance which can be

deformed plastically beforehand, it is possible to form the coated layer on the back plate first and then dry or gel the material in order to add plastic deformation.
[0031] In addition, the walls of the mold could be metal, resin, or rubber. These molds could be flat or a column shape with the cell wall pattern formed on its surface.
[0032] The insulating substrate which is used for the back plate and front plate of this invention can be a transparent substrate such as soda lime glass, low-soda glass, lead alkali silicon glass, or borosilicate glass. A soda glass with a high warp point is especially suitable.
[0033] Next, the electrode is formed using a conductive metal such as Ag, Ni, Al or their alloys. An electrically conductive paste made by mixing a small amount of glass with these metals or alloy can also be used. The front plate which is an insulating substrate on the display face side has transparent electrodes made vapor-deposited indium oxide or tin oxide.
[0034] The gas can have Xe or He-Xe, Ne-Xe as the main component. It is possible to form an electric discharge display cell where the gas pressure in the sealed cell is 10 to 600 Torr.

[0035]
(Examples of practice)

In the following, the cell walls for PDP in this invention and the manufacturing method are evaluated as explained below.
[0036]
(Example of practice 1)

First, a back plate which consisted of 2 mm thick soda lime glass 30 inches square was coated with an Ag based electrode paste by a thick film printing method to form 50 μm wide stripe electrodes with 220 μm pitch over the whole surface. After sintering, an electrode plate was manufactured.
[0037] Meanwhile, a flat metal cell wall mold was prepared. The wall section at the base was a curved surface with approximately 9 μm radius of curvature as seen from the center of the electric discharge display cell. Multiple grooves in the shape of the cell walls 40 μm wide, 200 μm high, and 220 μm pitch were formed on the mold.
[0038] Next, cell wall material which consisted of low-melting point glass powder, butyral resin, solvent, and a dispersing agent was applied uniformly on the electrode plate above using a roll coater. Then the flat metal cell wall mold above was pressed onto the coated layer to plastically deform it to form the cell walls in the desired shape. Next, the cell walls molding was released from the mold, and a cell wall molding was formed on the back plate.
[0039] After that, the assembly of back plate and cell wall molding was kept at a predetermined temperature and de-bindered. The sintering atmosphere was changed appropriately depending on the materials used. After sintering for 10 minutes at 550 to 580 C, cell walls for PDP attached to a back plate were manufactured.
[0040] When the shape of the cell wall base for PDP acquired above was observed by scanning electron microscope (SEM), it showed a uniform curved surface with approximately 10 μm radius of curvature.
[0041] The back plate with electrodes attached to the cell walls (before sintering) was passed through a line air shower at 1.0 air pressure and 10 cm height from back board with the cell walls facing up. After that, damage was assessed at 5 places – in the center and at the four

corners. The numbers of voids deformed cells per unit area (cm2) was counted, and the strength of the cell walls was evaluated.

[0042] The cell walls for PDP were evaluated after sintering by passing them under one line air shower at 5.0 pressure, and the strength of the cell walls was evaluated as was done before sintering.

[0043] A glass layer 200 μm thick was formed on a back plate using glass paste. After it was dried, a striped mask which had been set to the width of cell walls (approximately 40 μm) was used to form cell walls. These cell walls were sand blasted using glass beads at a pressure of approximately 1.5 to 3.0 kgf/cm2. This was used as an example of comparison.

[0044] The cell wall section at the base was straight and the cell walls were almost perpendicular to the back plate.

[0045] In the example of comparison, it was found that the number of defects per unit area was 10 in the center of the back plate, 11 in the upper right corner, 12 in the lower right corner, 9 in the lower left corner, and 13 in the upper left corner. Therefore, the strength of the cell walls was thought to be low. Compared to this, the molded cell walls for PDP in this invention had only one defect in the center of the back plate, and there was no defects or voids in other areas. The strength of the cell walls was thought to be high.

[0046]

(example of practice 2)

Example of practice 2 was the same as example of practice 1, except that the cell wall material was applied by a roll coater and dried for 1 hour at 80 C.

[0047] When the sectional shape of the cell wall base acquired in this example of practice was measured as in example of practice 1, it had a uniform curved surface with approximately 13 μm radius of curvature.

[0048] In addition, as a result of the same evaluation as in example of practice 1, there was no deformation or voids anywhere in the raw molding or after sintering. The strength of the cell walls was thought to be extremely high.

[0049]

(example of practice 3)

Using the same cell wall material as in example of practice 1, a block of cell wall material was pressed onto the mold and plastically deformed to form a cell wall molding. Next, a back plate was pressed onto this cell wall molding, and they were bonded together. After de-bindering, it was sintered, and a cell walls for PDP molding attached to a back plate was manufactured.

[0050] Next, it was evaluated as in example of practice 1. A uniform curved surface with approximately 10 μm radius of curvature was acquired. The cell walls for PDP in this example had no damage such as deformation or voids either before or after sintering. This result confirmed that the strength of the cell walls was extremely high.

[0051]

(example of practice 4)

Instead the flat metal mold in example of practice 1, a roll-shaped metal mold with a radius of curvature of approximately 25 μm was used. This mold had multiple grooves equivalent to cell walls 35 μm wide, 200 μm high, and 150 μm pitch. This mold was used to transcribed a back plate with a layer of the same cell wall material as in example of practice 1. Next, the cell wall shape was formed by plastic deformation of the coating layer, and cell walls for PDP were manufactured as in example of practice 1.

[0052] When this example was evaluated as in example of practice 1, a uniform curved surface with approximately 30 μm radius of curvature was acquired. There was no damage such as deformation or voids either before or after sintering. The strength of the cell walls was extremely high.

[0053]

(example of practice 5)

Instead of the flat metal mold made for cell walls used in example of practice 1, a roll shaped metal mold with a radius of curvature of the base of the cell wall with approximately 50 μm radius of curvature was used. It had multiple grooves equivalent to the cell walls with 40 μm width, 220 μm height, and 220 μm pitch. Cell walls for PDP for evaluation were manufactured as in example of practice 2.

[0054] When these cell walls were evaluated as in example of practice 1, a uniform curved surface with approximately 55 μm radius of curvature was acquired. There was no damage such as deformation or voids either before or after sintering. The strength of the cell walls was extremely high.

[0055]

(example of practice 6)

Instead of the flat metal mold made for cell walls used in example of practice 1, a roll shaped metal mold with a radius of curvature of the base of the cell wall of approximately 95 μm radius of curvature was used. It had multiple grooves equivalent to cell walls with 40 μm width, 220 μm height, and 250 μm pitch. Cell walls for PDP for evaluation was manufactured as well as example of practice 2.

[0056] When these cell walls were evaluated as in example of practice 1, a uniform curved surface with approximately 100 μm radius of curvature was acquired. There was no damage such as deformation or voids either before or after sintering. The strength of the cell walls was extremely high.

[0057] It is noted that this invention is not limited specifically to the above examples of practice.

[0058]

(Effects of this invention)

By using the cell walls for PDP in this invention and the manufacturing method, it is possible to increase production of cell walls used for electric discharge display cells of a PDP. The strength of the cell walls in the perpendicular direction is high. Shape defects such as voids or deformed cell walls are reduced, the manufacturing process is improved, and productivity is

much improved. In addition, it is possible to form cell walls which have a uniform curved surface at the base.

[0059] Cell walls for PDP with the following features can be acquired. The sectional shape of the base of the cell wall is formed with high accuracy and fine pitch. They are attached to a back plate and the joint makes a curved surface with a uniform radius of curvature. The thickness of the luminous layer formed in the bottom of the electric discharge display cell is uniform and has no cracks. These cell walls for PDP make electric discharge display cells which are highly detailed and accurate. These cell walls for PDP can be easily used for big screens such as 30 inches or more. The manufacturing method in this invention can be used to produce these cell walls inexpensively and effectively.

[Simpler explanation of figures]

Figure 1: Cross section of one example of practice of a PDP which uses the cell walls for PDP in this invention.

Figure 2: Cross section of the main part for explaining the cell walls for PDP of this invention.

Figure 3: Cross section of a favorable example of practice of the manufacturing method for cell walls for PDP in this invention.

Figure 4: Cross section of the main part for explaining the cell walls for PDP in the former case.

[Explanation of symbols]

1: cell walls for PDP
2: back plate
3: front plate
4: insulating substrate
5: electric discharging cell
6, 7: electrode
8: luminous body
9: PDP
10: base of cell walls
11: curved surface
12: coated layer cell wall material
13: groove
14: roll-shaped mold

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号

特開平10－326571

(43)公開日　平成10年(1998)12月８日

(51)Int.Cl.*	識別記号	ＦＩ	
Ｈ０１Ｊ　11/02		Ｈ０１Ｊ　11/02	Ｂ
9/02		9/02	Ｆ
17/16		17/16	
// Ｃ０３Ｃ　27/06	１０１	Ｃ０３Ｃ　27/06	１０１Ｚ

審査請求　未請求　請求項の数４　ＯＬ　（全６頁）

(21)出願番号　特願平9－137132

(22)出願日　平成９年(1997)５月27日

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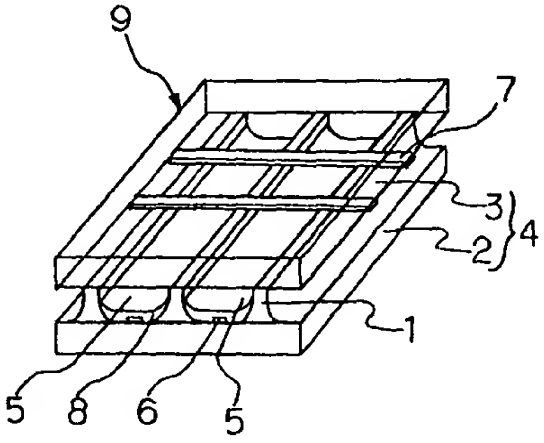
(54)【発明の名称】　プラズマディスプレイパネル用隔壁及びその製造方法

(57)【要約】

【課題】ＰＤＰの放電表示セルを構成する隔壁の形状欠陥を低減し、背面板と一体化した隔壁基部の断面形状が均一な曲率半径を有する曲面を成し、放電表示セルの底部に形成した蛍光体層の厚さが均一で割れもなく、高精細度化した放電表示セルを有する、大型画面化が容易なＰＤＰ用隔壁と、それを安価に効率良く製造する方法を提供する。

【解決手段】背面板上に被覆した隔壁成形用組成物の層を塑性変形して隔壁成形体を得、該隔壁成形体を背面板と共に脱バインダー処理後、焼成して一体化し、隔壁基部の断面形状が１０～１００μｍの範囲の曲率半径を有する曲面を成したプラズマディスプレイパネル用隔壁を得る。



【特許請求の範囲】

【請求項１】対向した背面板と正面板を成す絶縁基板と、該絶縁基板間の対向空間を仕切る隔壁とで複数の放電表示セルを構成し、該放電表示セル内に複数の電極群を設けると共に、放電ガスを気密封入し、前記電極間に電圧を選択的に印加してプラズマを発生させ、放電表示セル内壁に形成した蛍光体を発光させて画像表示装置の発光素子とするプラズマディスプレイパネルであって、前記背面板と一体化した隔壁基部の断面形状が１０～１００μｍの範囲の曲率半径を有する曲面を成すことを特徴とするプラズマディスプレイパネル用隔壁。

【請求項２】背面板上に隔壁成形用組成物から成る被覆層を形成し、該被覆層を塑性変形して隔壁成形体を成形し、次いで脱バインダー後、焼成して背面板と一体化した隔壁基部の断面形状が１０～１００μｍの範囲の曲率半径を有する曲面を成したプラズマディスプレイパネル用隔壁を得ることを特徴とするプラズマディスプレイパネル用隔壁の製造方法。

【請求項３】隔壁成形用組成物に隔壁成形型を押し付けて塑性変形させて隔壁成形体を成形した後、該隔壁成形体上に背面板を圧着して隔壁成形体を密着させ、脱バインダー後、焼成して背面板と一体化した隔壁基部の断面形状が１０～１００μｍの範囲の曲率半径を有する曲面を成したプラズマディスプレイパネル用隔壁を得ることを特徴とするプラズマディスプレイパネル用隔壁の製造方法。

【請求項４】前記隔壁成形体は、隔壁形状に相当する複数の溝を刻設したロール状成形型を、隔壁成形用組成物に押圧して塑性変形させて成形することを特徴とする請求項２または請求項３のいずれかに記載のプラズマディスプレイパネル用隔壁の製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、高精度かつ安価な軽量薄型の大型画面用カラー画像表示装置等に用いられるプラズマディスプレイパネル（以下、ＰＤＰと略記する）の放電表示セルを構成するＰＤＰ用隔壁及びその製造方法に関するものである。

【０００２】

【従来の技術】従来から画像表示装置としてはＣＲＴが多用されてきているが、該ＣＲＴには外形容積が大きく重量が大であること、高電圧が必要であること等の欠点があり、近年、マルチメディアの浸透に伴い、情報のインターフェースとして発光ダイオード（ＬＥＤ）や液晶表示素子（ＬＣＤ）、あるいはＰＤＰ等の平面画像表示装置が開発され、これらの利用範囲が拡大しつつある。

【０００３】なかでもＰＤＰは、プラズマ発光を利用した大型画面で高画質、更に薄型軽量で設置場所を選ばない大型画面用カラー画像表示装置として将来性が注目されている。

【０００４】かかるＰＤＰは、背面板と正面板の２枚の平坦な絶縁基板と、その空間を仕切る隔壁で囲まれた微小な放電表示セルに対向する電極群を設け、前記空間に希ガス等の放電ガスを気密封入した構造をしており、前記対向する電極間に電圧を選択的に印加し、放電によりプラズマを発生させ、該プラズマにより放電表示セル内の蛍光体を発光させて画面の発光素子として利用するものである。

【０００５】一般に、前記ＰＤＰの放電表示セルを構成する隔壁の製造方法としては、背面板上に隔壁成形用組成物から成るペーストをスクリーン印刷法により隔壁パターンで印刷・乾燥を繰り返し、所定の必要な高さまで積み重ねて隔壁形状を成形する方法が良く知られている。

【０００６】しかしながら、この方法では、１回の印刷で形成できる膜の厚さが約１０μｍ程度であることから、印刷・乾燥を繰り返しながら約１００～２００μｍ程度の高さを必要とする放電表示セルの隔壁を形成することから、何回も印刷・乾燥工程を繰り返して積層しなければならない。

【０００７】従って、極めて工程数が多くなる上、ダレが蓄積されて隔壁底部が広がってしまったり、印刷製版のメッシュに起因する背面板と隔壁の密着部における隔壁の裾の乱れや、印刷時の位置ズレにより隔壁が変形し易く、かつ印刷製版の伸び等も加わって良好な寸法精度が得られないことから、隔壁を微細なピッチで形成することに限界があり、高精細度化の要求を満足することができず、また、積層毎に精度よく印刷する必要があるため非常に歩留りが悪いという問題があった。

【０００８】そこで、かかる問題を解消する方法として、背面板上に必要な厚さで隔壁材料を層状に形成し、マスクパターンを用いてサンドブラスト加工で不必要な部分を研削除去して所望形状の隔壁を形成する方法が提案されている（特開平８－１１５６６９号公報参照）。

【０００９】

【発明が解決しようとする課題】前記サンドブラスト加工法では切り立った隔壁断面形状を成形でき、印刷積層法に見られるような隔壁の裾の乱れや隔壁底部の広がりを生ずることは無いものの、本加工法では隔壁を形成する部分以外の殆どの隔壁材料を研削除去しなければならず、コスト高であるという課題があった。

【００１０】また、更なる高精細な放電表示セルを形成するために極めて幅の狭い細長い隔壁を成形した場合、隔壁が高くなるほど、隔壁の配列方向と直行する方向の隔壁の剛性が弱まるため、隔壁の形成途中や焼成中に亀裂が生じたり、あるいは隔壁成形後のハンドリング中に欠けたりするという課題もあった。

【００１１】更に、前記切り立った断面形状を有する隔壁成形体を焼成すると図４に示すように、背面板１５と隔壁基部１６で形成される隅部１７が不規則に丸まって

しまい、放電表示セル１８の底部に蛍光体層１９を形成する際、蛍光体の充填不良を生じたり、蛍光体層の厚さのばらつき、あるいは焼き付け時に割れ２０を生じ、発光効率が下がったり、輝度がバラツクという課題があった。

【００１２】

【発明の目的】本発明は前記課題を解決するためになされたもので、その目的は、ＰＤＰの放電表示セルを構成する隔壁の欠け等の形状欠陥を低減させて製造歩留まりを向上させて生産性を高め、高精度で微細なピッチを有し、背面板と一体化した隔壁基部の断面形状が均一な曲率半径を有する曲面を成し、放電表示セルの底部に形成した蛍光体層の厚さも均一で割れもなく、いわゆる高精細度化した放電表示セルを多数有する、例えば３０インチ以上にも及ぶ大型画面化が容易なＰＤＰ用隔壁と、そのようなＰＤＰ用隔壁を安価にかつ効率良く製造する方法を提供することにある。

【００１３】

【課題を解決するための手段】本発明者等は前記課題に鑑み鋭意検討した結果、隔壁成形用組成物を塑性変形して成形した放電表示セルを構成する隔壁が、背面板につながる隔壁基部においてその断面形状が一定の曲率半径を有する曲面であることにより、隔壁の亀裂やハンドリング中の欠け等の形状欠陥が防止できるとともに、放電表示セルの底部には均一な厚さで割れ等の欠陥のない蛍光体層を形成でき、高精細度化が実現できることを見いだした。

【００１４】即ち、本発明のＰＤＰ用隔壁は、隔壁成形用組成物を塑性変形することにより得られた背面板と一体化した隔壁基部の断面形状が１０～１００μｍの範囲の曲率半径を有する曲面を成すことを特徴とするものである。

【００１５】また、本発明のＰＤＰ用隔壁の製造方法は、先ず背面板上に隔壁成形用組成物を所定厚さで層状に被覆形成した後、該被覆層を塑性変形して隔壁形状に成形して隔壁成形体を得、該隔壁成形体を接着した背面板ともども脱バインダーしてから焼成して背面板と一体化した隔壁基部の断面形状が１０～１００μｍの範囲の曲率半径を有する曲面を成したプラズマディスプレイパネル用隔壁を得ることを特徴とするものである。

【００１６】更に、本発明の他のＰＤＰ用隔壁の製造方法としては、隔壁成形用組成物に直接、隔壁成形型を押し付けて塑性変形させ、得られた隔壁成形体上に背面板を圧着して隔壁成形体を密着させ、前記同様に脱バインダー後、焼成して背面板と一体化した隔壁基部の断面形状が１０～１００μｍの範囲の曲率半径を有する曲面を成したプラズマディスプレイパネル用隔壁を得ることを特徴とするものである。

【００１７】特に、前記隔壁成形用組成物を塑性変形して隔壁を成形する方法としては、隔壁形状に相当する複数の溝を刻設し、隔壁の基部に相当する凸部端縁を所定曲率で断面円弧状に形成したロール状成形型を押し付けながら回転させて隔壁を成形する方法が最適である。

【００１８】

【作用】本発明のＰＤＰ用隔壁及びその製造方法によれば、放電表示セルを構成するＰＤＰ用隔壁は、背面板と一体化した隔壁基部の断面形状が一定範囲の曲率を有する曲面を成し、その製造方法は背面板上に形成した隔壁成形用組成物の被覆層を塑性変形して隔壁を成形し、得られた隔壁成形体を脱バインダーした後、焼成して背面板と一体化することから、隔壁基部の断面形状が均一な曲率の曲面となり該隔壁基部の応力集中を低減することができ、かつ、切り立った細長い断面形状のみから成る隔壁よりも隔壁断面積を増大させることができ、隔壁の配列方向と直行する方向に対する隔壁の剛性を高めることが可能となり、隔壁の変形や欠け等の形状欠陥を低減させて製造歩留まりを向上させ、隔壁基部に均一な曲面を有する隔壁を再現性良く、簡便な工程で得ることができ、蛍光体層も均一に形成することができ、製造コストの大幅な低減が可能となる。

【００１９】

【発明の実施の形態】以下、本発明のＰＤＰ用隔壁及びその製造方法について図面に基づき詳細に説明する。

【００２０】図１は、本発明のＰＤＰ用隔壁を有するＰＤＰの一実施例を示す斜視図であり、図２は本発明のＰＤＰ用隔壁を説明するための要部断面図である。

【００２１】図１及び図２において、１は対向した背面板２と正面板３を成す絶縁基板４と、複数の電極６、７と蛍光体８を有する放電表示セル５とから成るＰＤＰ９を構成するＰＤＰ用隔壁である。

【００２２】ＰＤＰ用隔壁１は、背面板２と一体化した隔壁基部１０の断面形状が一定の曲率半径の範囲内の均一な曲面１１を有するものである。

【００２３】本発明において、背面板２と一体化した隔壁基部１０の断面形状が成す曲面１１の曲率半径が、放電表示セル５の中心方向から見て曲面１１の一部でも１０μｍ未満の場合には隔壁の変形や欠けを低減する効果が少なく、１００μｍを越えると隔壁の靭性は向上するものの、発光空間が狭くなって輝度が低下する。

【００２４】従って、隔壁基部１０の断面形状が成す曲面１１の曲率半径は、放電表示セル５の大きさの如何を問わず、１０～１００μｍの範囲内であれば一定の曲率から成る円弧状の曲面でも、連続して曲率が変化する楕円状等、各種形状の曲面のいずれでも良く、とりわけ隔壁成形型を作製する上での容易さからは１５～７０μｍが好適である。

【００２５】次に、本発明のＰＤＰ用隔壁の製造方法は、図３にその一例を示すように背面板２上に形成した隔壁成形用組成物の被覆層１２を塑性変形して隔壁基部が一定の曲率を有する曲面１１となるようにＰＤＰ用隔

壁１を成形するものである。

【００２６】特に、隔壁形状に相当する複数の溝１３を刻設し、隔壁間の底部に相当する凸部の両端縁を所定の曲率で丸めて曲面としたロール状成形型１４を、前記隔壁成形用組成物の被覆層１２に矢印の方向に回転させながら押圧し、被覆層１２を塑性変形させて隔壁形状を写し取り、背面板２に密着した隔壁基部に曲面１１を有する隔壁成形体を得るものが最も効率良く、高精度に量産できるものである。

【００２７】前記隔壁成形用組成物の被覆層を塑性変形させる手段としては特に限定するものではなく、例えば、隔壁断面形状に対応するような平板状やロール状等の各種成形型を背面板上に形成した前記被覆層に押圧して隔壁成形体を形成する他、前記隔壁成形型を隔壁成形用組成物に押し付けたり、隔壁成形用組成物を押し込んで塑性変形した後、その上に背面板を圧着して転写させた後、成形型を離型して、背面板上に隔壁成形体を密着させても良い。

【００２８】また、前記隔壁成形用組成物としては、焼成後にガラス質となり、気密性を保持できるガラス材料であれば何れでも良く、例えば、低融点ガラス粉末と酸化物セラミックス粉末の混合物等を無機成分として使用することができ、該無機成分とバインダー、溶剤、各種添加物等の有機物との混合物を適宜、隔壁の成形方法に応じて調製して使用することができる。

【００２９】尚、前記塑性変形性を有する隔壁成形用組成物に好適な有機物としては、バインダーとして、例えば、アクリル系、ブチラール系等の熱可塑性バインダーあるいは紫外線硬化性樹脂や光硬化性樹脂、熱硬化性樹脂等の反応硬化性樹脂を用いることができる。

【００３０】一方、背面板に形成した前記隔壁成形用組成物の被覆層に塑性変形性を付与する方法としては、前記塑性変形性を呈する有機物を予め隔壁成形用組成物に添加しておく以外に、先ず、背面板に被覆層を形成した後、乾燥、ゲル化等の後処理を施して塑性変形性を付与しても良い。

【００３１】また、隔壁成形型は、金属製、樹脂製、ゴム製等のいずれでも良く、それら成形型の形状は、隔壁に対応する凹凸をその表面に形成した平板状あるいは円柱状等の何れでも良い。

【００３２】また、本発明の背面板及び正面板に用いる絶縁基板としては、ソーダライムガラスや低ソーダガラス、鉛アルカリケイ酸ガラス、ホウケイ酸塩ガラス等の透明ガラス基板を用いることができ、特に高歪点低ソーダガラスが好適である。

【００３３】尚、電極としては、Ａｇ、Ｎｉ、Ａｌ等の導体金属、あるいはこれらの合金、または前記導体金属やその合金に少量のガラスを混合した導電性ペーストを用いて形成されているが、表示面側の絶縁基板である正面板には酸化インジニウムや酸化スズ等を蒸着した透明電極が形成されている。

【００３４】また、気密封入する放電ガスには、ＸｅやＨｅ－Ｘｅ、Ｎｅ－Ｘｅ等を主成分として用いることができ、１０～６００Ｔｏｒｒ封入して放電表示セルを形成させることができる。

【００３５】

【実施例】次に、本発明のＰＤＰ用隔壁及びその製造方法について以下のようにして評価した。

【００３６】（実施例１）先ず、厚さ２ｍｍの３０インチサイズのソーダライムガラスから成る背面板上に、厚膜印刷法によりＡｇを主成分とする電極ペーストを用いて幅５０μｍの電極をストライプ状に２２０μｍピッチで全面に形成して焼き付け、電極付き背面板を作製した。

【００３７】一方、隔壁基部の断面形状が放電表示セル中心部から見た曲率で約９μｍの曲面を有し、幅が４０μｍ、高さが２００μｍ、ピッチが２２０μｍに相当する隔壁形状の凹型の溝を多数形成した平板状の金属製の隔壁成形型を準備した。

【００３８】次に、前記電極付き背面板上に低融点ガラス粉末とブチラール樹脂、溶媒、分散剤から成る隔壁成形用組成物をロールコーターにて均一に塗布して被覆層を形成した後、前記平板状の金属製隔壁成形型を該被覆層が形成された背面板に加圧圧着し、隔壁成形用組成物から成る被覆層を塑性変形させて隔壁形状を付与した後、隔壁成形型を離型して背面板上に隔壁成形体を形成した。

【００３９】次いで、前記隔壁成形体を密着した背面板を所定温度に保持して脱バインダーした後、各材料主成分により焼成雰囲気を適宜変更し、５５０～５８０℃の温度で１０分間焼成して背面板と一体化した評価用のＰＤＰ用隔壁を作製した。

【００４０】かくして得られた評価用のＰＤＰ用隔壁の基部断面形状を走査型電子顕微鏡（ＳＥＭ）で拡大して観測したところ、曲率が約１０μｍの均一な曲面を有していた。

【００４１】先ず、焼成前の隔壁成形体を有する電極付き背面板を用い、該背面板の隔壁側を上にして背面板から１０ｃｍの高さに配置した１．０気圧の空気を吹き出す一列のエアーシャワーの下を強制的に通過させた後、背面板の中央と四隅の合計５ヶ所の隔壁について単位面積（cm^2）当たりの隔壁の変形や欠け等の欠陥の発生数をカウントして隔壁の剛性を評価した。

【００４２】更に、焼成後の評価用のＰＤＰ用隔壁に対して、該ＰＤＰ用隔壁を５．０気圧の空気を吹き出す一列のエアーシャワーの下を通過させ、焼成前の評価と同様にして隔壁の剛性を評価した。

【００４３】尚、背面板上にガラスペーストを用いて厚さ２００μｍのガラス層を形成し、乾燥させた後、隔壁の幅が約４０μｍとなるように設定したストライプ状の

マスクパターンを用い、ガラスビーズを切削粉として噴出圧力を１．５～３．０ｋｇｆ／ｃｍ^{2}程度に設定したサンドブラスト法で隔壁を作製したものを比較例とした。

【００４４】尚、比較例で得られた隔壁成形体の基部断面形状は直線性を有し、背面板とほぼ直角を成して隔壁は形成されていた。

【００４５】以上の結果、比較例では隔壁成形体の単位面積当たりの欠陥数が、背面板の中央部では１０個、右上端部で１１個、右下端部で１２個、左下端部で９個、左上端部で１３個認められ、隔壁の剛性が低いのに対して、本発明のＰＤＰ用隔壁成形体では、背面板の中央部でわずかに１個の欠陥が認められたものの、その他では変形や欠けは全く認められず、隔壁の剛性が高いことが確認できた。

【００４６】（実施例２）実施例１の隔壁成形用組成物をロールコーターにて実施例１の背面板上に均一に塗布した後、８０℃の温度で１時間の乾燥を施し、他は実施例１と同様にして評価用のＰＤＰ用隔壁を作成した。

【００４７】かくして得られた評価用のＰＤＰ用隔壁の基部断面形状を実施例１と同様にして測定したところ、曲率が約１３μｍの均一な曲面を成していた。

【００４８】また、実施例１と同様にして評価した結果、本発明のＰＤＰ用隔壁では、隔壁成形体及びその焼結体のいずれも、変形や欠け等の欠陥は全く認められず、極めて隔壁の剛性が高いことが確認できた。

【００４９】（実施例３）実施例１と同一の隔壁成形用組成物と隔壁成形型を用い、隔壁成形型に隔壁成形用組成物のブロックを押し付けて塑性変形させて隔壁成形体を成形した後、該隔壁成形体上に背面板を圧着して隔壁成形体を密着させ、脱バインダー後、焼成して背面板と一体化した評価用のＰＤＰ用隔壁を作製した。

【００５０】次いで、実施例１と同様にして評価したところ、曲率が約１０μｍの均一な曲面が得られ、本発明のＰＤＰ用隔壁には焼成前後のいずれにおいても変形や欠け等の欠陥は全く認められず、極めて隔壁の剛性が高いことが確認できた。

【００５１】（実施例４）実施例１の平板状の金属製の隔壁成形型に代えて、表面に隔壁基部の断面形状が約２５μｍの曲率を有し、隔壁の幅が３５μｍ、高さが２００μｍ、ピッチが１５０μｍの隔壁に相当する凹型の溝を複数刻設したロール状の金属製隔壁成形型を用い、実施例１と同一の隔壁成形用組成物の被覆層が形成された背面板上を加圧転造して、該被覆層を塑性変形させて隔壁形状を付与させ、実施例１と同様にして評価用のＰＤＰ用隔壁を作製した。

【００５２】かくして得られた評価用のＰＤＰ用隔壁を用いて実施例１と同様に評価したところ、曲率が約３０μｍの均一な曲面が得られ、本発明のＰＤＰ用隔壁には焼成前後のいずれにおいても変形や欠け等の欠陥は全く認められず、極めて隔壁の剛性が高いことが確認できた。

【００５３】（実施例５）実施例１の平板状の金属製の隔壁成形型に代えて、表面に隔壁基部の断面形状が約５０μｍの曲率を有し、隔壁の幅が４０μｍ、高さが２００μｍ、ピッチが２２０μｍの隔壁に相当する凹型の溝を複数刻設したロール状の金属製隔壁成形型を用い、実施例２と同様にして評価用のＰＤＰ用隔壁を作製した。

【００５４】得られた評価用のＰＤＰ用隔壁を実施例１と同様に評価したところ、曲率が約５５μｍの均一な曲面が得られ、本発明のＰＤＰ用隔壁には焼成前後のいずれにおいても変形や欠け等の欠陥は全く認められず、極めて隔壁の剛性が高いことが確認できた。

【００５５】（実施例６）実施例１の平板状の金属製の隔壁成形型に代えて、表面に隔壁基部の断面形状が約９５μｍの曲率を有し、隔壁の幅が４０μｍ、高さが２００μｍ、ピッチが２５０μｍの隔壁に相当する凹型の溝を複数刻設したロール状の金属製隔壁成形型を用い、実施例２と同様にして評価用のＰＤＰ用隔壁を作製した。

【００５６】得られた評価用のＰＤＰ用隔壁を実施例１と同様に評価したところ、曲率が約１００μｍの均一な曲面が得られ、本発明のＰＤＰ用隔壁には焼成前後のいずれにおいても変形や欠け等の欠陥は全く認められず、極めて隔壁の剛性が高いことが確認できた。

【００５７】尚、本発明は前記詳述した実施例に何等限定されるものではない。

【００５８】

【発明の効果】本発明のＰＤＰ用隔壁及びその製造方法によれば、ＰＤＰの放電表示セルを構成する隔壁の断面積を増大させることができ、隔壁の配列方向と直行する方向に対する隔壁の剛性が高くなり、隔壁の変形や欠け等の形状欠陥が低減されて製造歩留りが向上して生産性が高まり、その上、簡便にその基部が均一な曲面を有する隔壁を形成することができる。

【００５９】従って、高精度で微細なピッチを有し、背面板と一体化した隔壁基部の断面形状が均一な曲率半径を有する曲面を成し、放電表示セルの底部に形成した蛍光体層の厚さも均一で割れもなく、いわゆる高精細度化した放電表示セルを多数有する、例えば３０インチ以上にも及ぶ大型画面化が容易なＰＤＰ用隔壁と、そのようなＰＤＰ用隔壁を安価にかつ効率良く製造する方法が得られる。

【図面の簡単な説明】

【図１】本発明のＰＤＰ用隔壁を有するＰＤＰの一実施例を示す斜視図である。

【図２】本発明のＰＤＰ用隔壁を説明するための要部断面図である。

【図３】本発明のＰＤＰ用隔壁の製造方法の好適な一実施例を示す斜視図である。

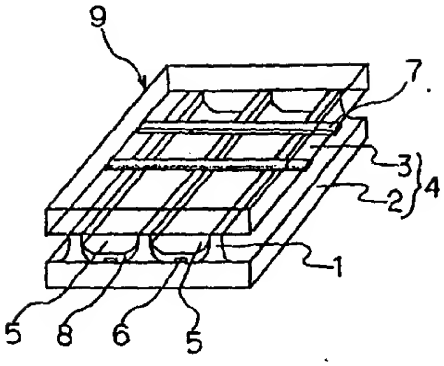
【図４】従来のＰＤＰ用隔壁を説明するための要部断面

図である。

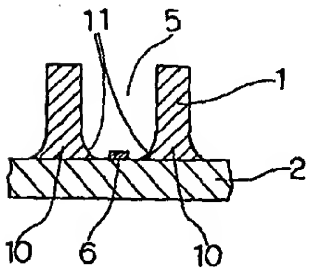
【符号の説明】

1　PDP用隔壁
2　背面板
3　正面板
4　絶縁基板
5　放電表示セル
6、7　電極
8　蛍光体
9　PDP
10　隔壁基部
11　曲面
12　隔壁成形用組成物の被覆層
13　溝
14　ロール状成形型

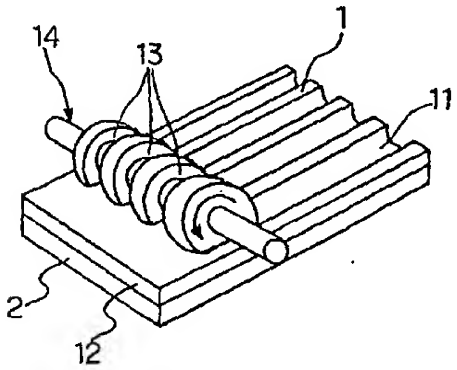
【図1】



【図2】



【図3】



【図4】